Eye of Poseidon: Collecting, Organizing and Modeling with Geospatial Resource and Habitat Data to Help Identify Targets for Marine Protected Area Designation

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Abstract

Over the last year, People For Puget Sound has collected and connected geospatial datasets for important habitats and marine species, bathymetric contours, public lands and marine parks, and local and cultural knowledge. Using the best data available, People For Puget Sound has worked with Canadian and American groups to map these factors as part of a Transboundary Geographic Information System. This Marine Resource Atlas is the foundation of a modeling tool designed to target and identify a system of Marine Protected Areas in the northern Sound and Straits. Identifying, collecting and compiling data for important marine habitats and species is the first step in creating a methodology for locating areas of biological importance. Defining nearshore and marine zones based on bathymetry creates two distinct sets of characterization and analysis. A preliminary list of key marine and nearshore habitats and species provide a simple set of site selection criteria. Early results from the site selection model will be presented.

Introduction

Credible reports have documented the dramatic decline in the health and abundance of most marine species in the Inland Sea (summarized in West 1997). The causes of decline are many, including nearshore and estuarine habitat loss, water and sediment contamination, reduced abundance of prey, over-harvest and human disturbance from recreational activities and marine transportation. To address these causes will require multiple strategies including: support and involvement of the public and user groups; gathering and intelligently applying scientific data; and monitoring, evaluation and adjustment of the strategies employed.

Existing federal and state laws are designed to address declines in individual species abundance and threats to the continued existence of those species recognized as endangered or threatened. Several resident and seasonal populations have been considered for listing under the U.S. Endangered Species Act (ESA), these include resident populations of salmon, rockfish, herring, lingcod, hake and most recently orca whales. Due to their relationship with stocks outside of Puget Sound and the Strait of Georgia, relatively few marine species have received protection under federal law. Washington and British Columbia have provided protection by listing species and their habitats as priority habitats and species or on the red and blue lists respectively.

Management of individual species without considering the ecosystem upon which they depend is a common criticism of endangered species management plans. Habitat conservation and, in particular, the setting aside of strategic areas as parks, refuges and no-take areas represents an important strategy that, when coupled with single species management plans, can effectively conserve species and their ecosystems.

While habitat has been set aside in national and international parks for more than a century, only recently have marine parks become a tool for conservation. Marine Protected Areas (MPAs) are “any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (Kelleher 1999). The size and shape of marine protected areas can vary widely from 14 acres (McArdle 1997) to the 5,300-square-mile Monterey Bay National Marine Sanctuary in California. MPAs are a proven tool for conserving biodiversity, managing natural resources, protecting endangered species, reducing user conflicts, providing educational and research opportunities and enhancing commercial and recreational activities (Salm and others 2000).

Here we examine the methods being employed to identify "core" MPAs within the Orca Pass International Stewardship Area. Our primary goal in identifying core areas that might serve as MPAs is to identify those areas that contain the most biodiversity and ecological productivity. Endangered and threatened species are being used to guide site identification along with habitat characteristics, human use and human disturbance.

About Orca Pass

Since 1991, British Columbia and Washington State non-governmental conservation organizations such as Georgia Strait Alliance and People For Puget Sound have worked cooperatively as the Sound & Straits Coalition to address transboundary marine issues. Since the fall of 1999, Sound & Straits Coalition groups (People For Puget Sound, Friends of the San Juans, Waldron Community, Evergreen Islands, Washington Scuba Alliance, Tokitae Foundation, Georgia Strait Alliance, Canadian Parks and Wilderness Society, Living Oceans Society, Underwater Clubs of British Columbia, Galliano Island Conservancy, Oceans Blue Foundation) have met to identifying a cross-border region that would be the focus of a citizens' initiative to move governments and tribes towards cooperatively establishing protected areas in the transboundary waters. Lummi, Swinomish, Tulalip, Coast Salish tribes and BC Aboriginal Fishers and Northwest Indian Fisheries Commission representatives have participated in Orca these discussions. This cooperative effort had as its condition the full recognition of tribal co-management rights, the involvement of all interested publics, and compliance—through education and enforcement—of all applicable federal, provincial, state and local laws and regulations.

The Orca Pass International Stewardship Area (figure 1) has been formally adopted by the BC Islands Trust Association and San Juan County's Board of County Commissioners in a "working agreement" with the Sound & Straits Coalition signed in November 2000. Islands Trust, San Juan County, the Sound & Straits Coalition, government agencies, and Native Tribes began discussions in May 2001 of a shared strategy to protect and restore critical habitats and resources through designation of network of marine protected areas within the Stewardship Area boundary.

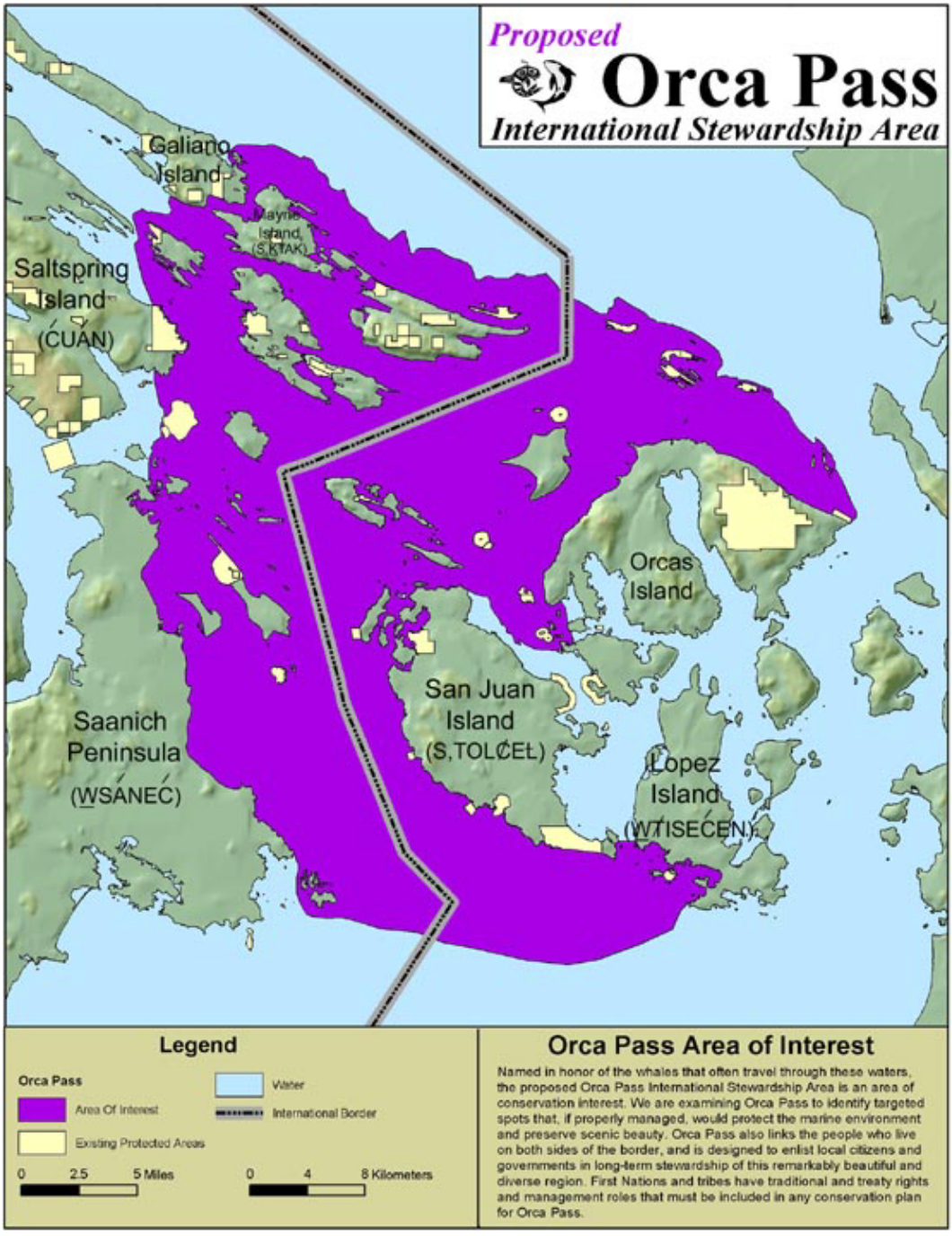

Figure 1. Orca Pass Area of Interest.

The Orca Pass International Stewardship Area has four goals:

1. To protect and restore important habitats with specific attention to reefs and intertidal and nearshore marine zones that benefit the widest diversity of species.
2. To establish and monitor specific protected zones within the Area, based on science and local/traditional knowledge, and to measure and report on species health, abundance and diversity.
3. To increase and sustain healthy populations of key species of fish, marine mammals, marine birds, marine plants, crustaceans, mollusks, and other invertebrates.
4. To prevent land and water pollution by petroleum products, toxic chemicals, sewage, plastics, and non-native plant and animal species.

Despite the political boundary, the transboundary waters within the Stewardship Area between BC and Washington State really make up a single ecosystem. They're home to the same marine creatures—from orca whales to oystercatchers—and are affected by the same types and sources of pollutants and habitat and population disruptions.

Methods

Once the commitment to conserving a significant amount of biodiversity is made, there is a need to explicitly identify which discrete locations should be preserved. Due to economic and political constraints on the amount of land/water that may be set aside for conservation, there is a need to identify areas that efficiently protect and ensure the survival of both individual species and ecosystem functions.

The class of reserve design problems that we are addressing is one where the goal is to achieve some minimum representation of biodiversity features for the smallest possible cost (Possingham and others 2000). This method attempts to achieve goals of species or habitat representation within a reserve using the least possible cost. Cost can either be represented simply as the area included in a conservation network, or an integration of the expected socioeconomic costs to establish the identified network. These methods identify a network of areas that meet species representation goals with the fewest possible locations.

For Orca Pass the species and habitats of interest were identified as those species and habitats listed on the Priority Habitat and Species List (WDFW 1996) and Red and Blue lists (CDC 2001). All existing spatial data for these resources was then collected from appropriate state, federal and provincial government agencies. Due to difficulties encountered while collecting spatial data for British Columbia, the analyses here are largely limited in scope to the United States portion of the study area. Where data is presented for Canada this represents only those spatial data sets that are widely available and are presented here for illustrative purposes only.

There are several details concerning spatial data that had to be examined before they could be integrated into a common decision framework. Primary among these is that spatial data is of varying quality depending on the species and survey that the data is derived from. Data collected using inconsistent survey methodologies, incomplete surveys, and surveys designed for a specific purpose other than assessing the distribution and abundance of a given species must all be manipulated before data for different species can be analyzed together. For the purposes of this analysis we reclassified all spatial data into one of three classes: locations where species were observed (confirmed present); locations that have never been surveyed or of unknown survey status (unknown status); and locations that have been surveyed and species were not observed (presumed absent).

Once species and habitat distribution information is in a common currency we can begin doing multi-species comparisons. The simplest of these is to calculate the species richness for a given site. Geographic Information Systems facilitates the combining or layering of different data sets to integrate the amount of resources found at a given location (Figure 2). For Orca Pass we chose to subdivide the area of interest into 25-hectare subsections for analytical purposes. This size of analytical unit enables us to perform analyses at approximately the same scale that many of the species of interest interact with their environment.

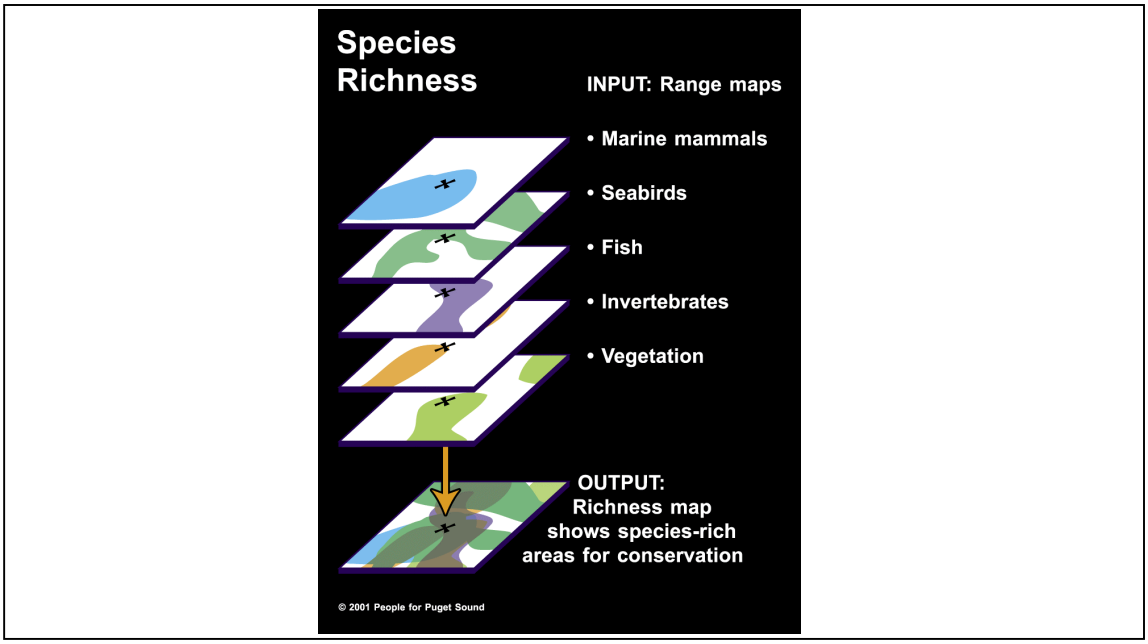

Figure 2. Calculating species richness using GIS.

While representing biological "hotspots" for species of interest is valuable from a planning perspective, it falls far short of our goal of identifying discrete locations that might serve as core MPAs. We use a heuristic algorithm that was originally developed by Ian Ball and Hugh Possingham and later adapted to work with commercial software for The Nature Conservancy (Andelman and others 1999). This algorithm, SITES, use a procedure known as "simulated annealing" for making selections that attempt to meet stated quantitative conservation goals as efficiently (using as few planning units) as possible.

Goals for species and habitat representation were developed based on guidance provided by documents like the Priority Habitats and Species List (WDFW 1996) that identify qualitative goals for species protection. These goals were incorporated into our modeling efforts by assigning quantitative goals to management suggestions as follows: 100% of occurrences (critically endangered species where all viable occurrences are protected); 40% of occurrences (depressed or declining species where spawning or aggregations should be protected); and 20% of occurrences (species of concern).

Results

Species richness analyses (Figure 3) enable us to identify the number of species of interest occurring throughout the study area. This methodology clearly identified a small number of relatively shallow bays as home to most of the species of interest. The most notable of these are the South-western shore of Lopez Island, Roche Harbor on San Juan Island and water between Spieden and Stuart Islands. Additionally, shorelines as a general conservation target are clearly delineated using this method as important areas for conservation.

When data was integrated into the SITES computer application, the results shifted from a gradient of potential conservation values to binary selected or not selected locations throughout the study area (Figure 4). The optimal solution identified using the existing spatial data and stated goals found that species representation goals were reached by protecting approximately 10,500 hectares (26,000 acres) of land as "core" MPAs. While several of the protected areas were isolated, there were aggregations of selected sites near Cattle Point, Roche Harbor, Sucia and Spieden Islands.

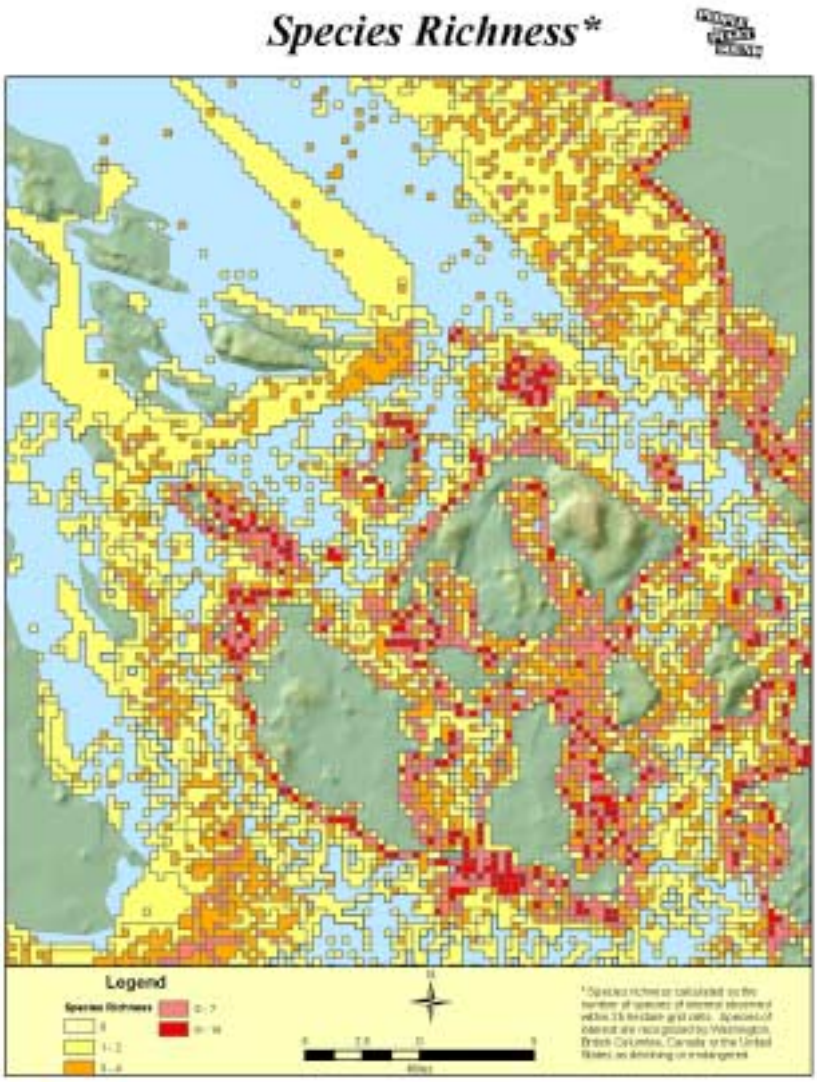

Figure 3 Species richness for species of interest within study area.

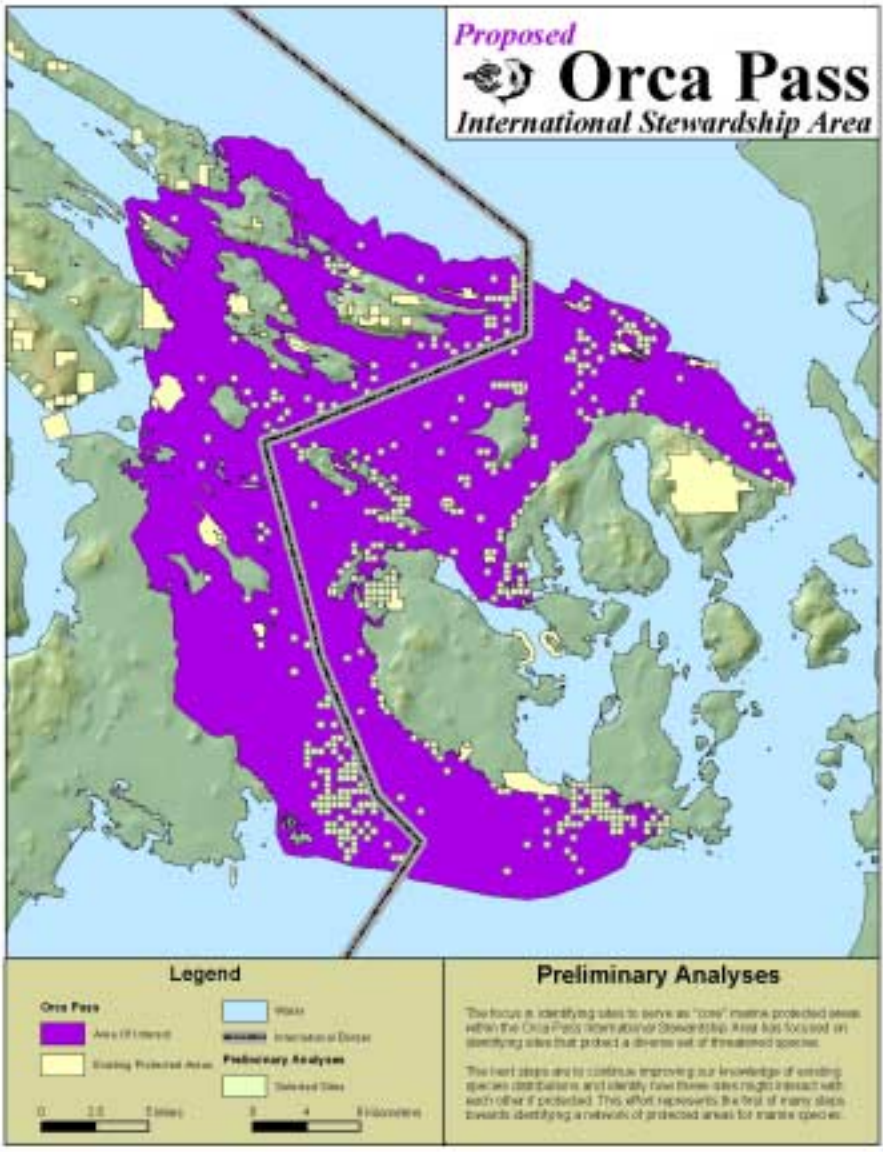

Figure 4: 461 25-hectare sites were identified using the SITES algorithm.

Conclusion

Our efforts to identify and protect the resources of Puget Sound are still in their nascent stages, but through this effort we have outlined a viable mechanism for identifying core MPAs within a study area. The need to protect marine resources in Puget Sound is well documented, and the Orca Pass study area represents some of the most productive and biologically rich areas in the region.

Our work is just beginning as we continue to refine our site selection methodologies and collect more and more accurate information about the distribution of biological resources in our study area. Site selection algorithms are heavily dependent on the information input and extremely sensitive to user goals, so care must be taken to standardize the quality of data being entered into these algorithms and to establish widely accepted goals. Towards this end People For Puget Sound, along with partner organizations, has convened groups of species and resource managers to discuss the quality of existing spatial data and to augment

existing resources. Goal setting is a much more difficult, and somewhat ambiguous goal. The best solution is likely to run algorithms at a variety of goals to obtain optimal results, but the true amount of resources that must be protected to ensure a healthy ecosystem will only be identified through empirical tests.

Additionally, site selection to date has avoided the issue of interactions between MPA sites. Since effective MPAs must be self-sustaining and capable of supplying larvae to other protected and unprotected areas (e.g. Carr and Reed 1993) it is important to consider linkages and connections between MPAs. To include this feature in our analytical framework we intend to expand our methods by re-evaluating all sites as each site is selected for inclusion in the network. Such an iterative step will explicitly enable us to account for oceanographic interactions between locations and linkages within the network.

Ongoing progress in analyses and products can be accessed through People For Puget Sound's website, www.pugetsound.org, and Georgia Strait Alliance, www.georgiastrait.org.

Acknowledge

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